General

Guideline Title

ACR Appropriateness Criteria® staging of pancreatic ductal adenocarcinoma.

Bibliographic Source(s)

Qayyum A, Tamm EP, Kamel IR, Allen PJ, Arif-Tiwari H, Chernyak V, Gonda TA, Grajo JR, Hindman NM, Horowitz JM, Kaur H, McNamara MM, Noto RB, Srivastava PK, Lalani T, Expert Panel on Gastrointestinal Imaging. ACR Appropriateness CriteriaÂ® staging of pancreatic ductal adenocarcinoma. Reston (VA): American College of Radiology (ACR); 2017. 12 p. [57 references]

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

NEATS Assessment

National Guideline Clearinghouse (NGC) has assessed this guideline's adherence to standards of trustworthiness, derived from the Institute of Medicine's report Clinical Practice Guidelines We Can Trust.

= Poor = Fair = Good = Very Good = Excellent

Assessment	Standard of Trustworthiness
YES	Disclosure of Guideline Funding Source
	Disclosure and Management of Financial Conflict of Interests
	Guideline Development Group Composition
YES	Multidisciplinary Group
YES	Methodologist Involvement

▮▯▯▯▯	Patient and Public Perspectives
	Use of a Systematic Review of Evidence
▮▮▮▮▮	Search Strategy
▮▮▮▯▯	Study Selection
▮▮▮▮▯	Synthesis of Evidence
	Evidence Foundations for and Rating Strength of Recommendations
▮▮▯▯▯	Grading the Quality or Strength of Evidence
▮▮▮▮▮	Benefits and Harms of Recommendations
▮▮▮▮▮	Evidence Summary Supporting Recommendations
▮▮▮▮▯	Rating the Strength of Recommendations
▮▮▮▮▮	**Specific and Unambiguous Articulation of Recommendations**
▮▯▯▯▯	**External Review**
▮▮▮▯▯	**Updating**

Recommendations

Major Recommendations

ACR Appropriateness Criteria®

Staging of Pancreatic Ductal Adenocarcinoma

Variant 1: Pancreatic ductal adenocarcinoma. Initial staging pretreatment.

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen without and with IV contrast	Usually Appropriate	O
MRI abdomen without IV contrast	May Be Appropriate	O
FDG-PET/CT skull base to mid-thigh	May Be Appropriate	☢☢☢☢
US abdomen endoscopic	May Be Appropriate	O
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢
US abdomen transabdominal	Usually Not Appropriate	O

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Pancreatic ductal adenocarcinoma. Follow-up post-neoadjuvant therapy. Evaluate resectability

for borderline resectable tumor.

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen without and with IV contrast	Usually Appropriate	O
MRI abdomen without IV contrast	May Be Appropriate	O
FDG-PET/CT skull base to mid-thigh	May Be Appropriate	☢☢☢☢
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢
US abdomen endoscopic	Usually Not Appropriate	O
US abdomen transabdominal	Usually Not Appropriate	O

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

Introduction/Background

Prevalence, Etiology, Treatment, and Prognosis

According to the American Cancer Society, the number of new pancreatic cancer cases estimated in the United States in 2017 is 53,670. The estimated number of deaths is 43,090 in 2017, with pancreatic adenocarcinoma remaining the fourth leading cause of cancer-related death in the United States. Difficulty in early detection and lack of effective screening methods invariably results in an advanced stage at presentation and poor prognosis.

Associated risk factors include tobacco use (20% of patients), family history of pancreatic cancer (two or more first-degree relatives with pancreatic cancer reported in 10% of patients), chronic pancreatitis, diabetes, obesity, hereditary pancreatitis and genetic alterations such as *BRCA1*, *BRCA2*, *PALB2*, *p16* gene mutations; Lynch syndrome; and Peutz-Jeghers syndrome. Screening is not currently recommended for the general population (U.S. Preventive Services Task Force gives a D recommendation). However, some have suggested that screening patients at high risk of developing pancreatic cancer is feasible, while acknowledging that data for cost-effectiveness and benefit are still required. To date, the most suitable imaging technology for such screening is unclear. No specific tumor markers for pancreatic cancer exist, and although most patients will demonstrate elevation in serum cancer antigen 19-9, this has low specificity and is more often used to indicate disease progression.

Pancreatic cancer develops insidiously in the exocrine cells, and as such, early disease is often asymptomatic or presents with vague symptoms such as loss of appetite, fatigue, and general malaise. Consequently, 80% to 85% of patients present with advanced disease without the option of surgical resection.

Overall survival for pancreatic cancer is 28% after 1 year and 7% after 5 years. Localized pancreatic cancer, reportedly diagnosed in 9% of patients, is associated with a 26% 5-year survival. Distant stage disease at diagnosis is associated with only a 15% 1-year and 2% 5-year survival. Given the poor prognosis, accurate staging is essential and pivotal to patient management decisions that are decided through a multidisciplinary approach. Imaging plays a critical role in pancreatic cancer staging and therapeutic decision process. The imaging armamentarium used to evaluate pancreatic cancer includes multidetector computed tomography (MDCT), magnetic resonance imaging (MRI), endoscopic ultrasound (EUS), and fluorine-18-2-fluoro-2-deoxy-D-glucose positron emission tomography (FDG-PET)/CT.

According to the AJCC (American Joint Committee on Cancer) handbook, pancreatic cancer is staged according to TNM (tumor, node, metastases) classification. TX and T0 refer to tumors that cannot be evaluated or when there is no evidence for a primary tumor, respectively. T1 tumors are entirely intrapancreatic and ≤2 cm. T2 tumors are entirely intrapancreatic and >2 cm. T3 tumors extend beyond

the pancreas without involvement of either the celiac or superior mesenteric arteries. T4 tumors involve the superior mesenteric or celiac arteries. NX refers to the inability to evaluate the status of lymph nodes, whereas N0 indicates no nodal involvement and N1 designation refers to tumor involvement of regional nodes. M0 means no metastatic involvement, whereas M1 designation means there are distant metastases.

Key determinants of tumor stage can be summarized as follows: Stage IV disease is the presence of any distant metastases, stage III disease is any T4 disease, stage IIA disease is T3 disease with no distant metastases or nodal involvement, stage IIB disease is T1 through T3 disease with nodal involvement, stage IA is T1 disease without nodal involvement, and stage IB is T2 disease without nodal involvement.

Treatment options include surgery, radiation therapy, and chemotherapy. Radical surgical resection offers potentially curative therapy, though it is seldom achieved. Furthermore, the general procedure-related morbidity rate is high at 20% and mortality rate is 1% to 4%.

Less than 20% of patients are candidates for surgery. For those undergoing surgery, the cancer is often too extensive for removal. Adjuvant chemotherapy with gemcitabine or chemoradiation after surgery has been reported by some to improve survival, but this is controversial due to conflicting published results. Use of combination systemic therapy with gemcitabine and the targeted anticancer drug erlotinib, has been suggested to slightly increase survival in patients with advanced cancer.

Cure rates are highest for tumors that are truly localized to the pancreas (without extension beyond the pancreatic capsule or lymph node metastases). Surgical resection of small, localized tumors, (measuring <2 cm in maximum diameter), are associated with a survival rate of 18% to 24%.

Decisive factors determining tumor resectability include presence of distant metastases, and vascular involvement particularly the celiac axis, superior mesenteric artery (SMA), superior mesenteric vein (SMV), and portal vein (PV). Motivation in efforts to increase surgical candidates is consequent to complete tumor resection being the sole option for cure. Close collaborative efforts between surgeons, oncologists, radiation oncologists, and diagnostic imaging has resulted in the development of resectable and borderline resectable disease criteria over the last decade. Increasingly sophisticated surgical techniques, including complex vascular reconstruction and use of neoadjuvant and adjuvant therapies have increased demand of more detailed and specific radiological interpretation of disease extent. Surgical definition of borderline resectable pancreatic cancer is based on five important observations: 1) long-term survival necessitates complete resection of the primary tumor and regional lymph nodes; 2) negative resection margins are less likely with increasing tumor involvement of the SMV-PV and SMA; 3) SMV-PV and hepatic artery resection (not SMA) at pancreatectomy has been associated with acceptable outcomes; 4) administration of conventional cytotoxic agents rarely results in down-staging locally advanced pancreatic cancer; and 5) tumor response to neoadjuvant chemotherapy and chemoradiation may be indicative of favorable tumor physiology and biology, and thus used to select patients who may benefit from aggressive surgery.

The most commonly used criterion for defining borderline resectable pancreatic cancer is radiologic evidence of <180° tumor interface to SMA. However, there is a lack of consensus on criteria for SMV involvement. Principally, differences in distinguishing borderline resectable and resectable cancer are based on radiologic determination of SMV-PV involvement. The American Hepatopancreatobiliary Association (AHPBA), Society for Surgery of the Alimentary Tract (SSAT), and the Society of Surgical Oncology (SSO) consider any degree of SMV-PV abutment criterion for borderline resectable cancer. MD Anderson categorizes presence of venous occlusion as a feature of borderline resectable cancer, but tumor abutment (≤180°) or encasement (>180°) of SMV-PV as resectable cancer. Patients with both borderline resectable or resectable pancreatic cancer are treated with neoadjuvant chemoradiation at this institution. Current surgical techniques are directed at removing sites of potential perineural tumor spread by performing vascular resection if there is possibility of the two venous ends being joined by a single lumen. Types of vascular reconstruction include venous grafts (saphenous vein), interposition grafts (internal jugular vein), primary anastomosis if there is sufficient native vein available, or splenic ligation.

Overview of Imaging Modalities

Radiologic evaluation of patients with pancreatic cancer for staging should assess tumor size, extension of tumor beyond the pancreas including adjacent significant vasculature (namely the SMA, celiac artery, common hepatic artery, and splenic artery, hepatic arterial variants, and the main PV, splenic vein, SMV, and whether the tumor is extending to divisions of these veins, which would preclude placement of a graft), presence of regional adenopathy (especially nodes that may be beyond the surgical field and may be suspicious, based on size or morphology), and whether there is metastatic involvement of the liver, peritoneum, and lungs.

US

Transabdominal ultrasound (US) is typically used in the initial workup of abdominal pain or suspected obstructive jaundice and has been addressed separately in the ACR Appropriateness Criteria® jaundice . Difficulties in visualizing the pancreas in detail because of either body habitus or commonly interposed bowel gas limit its usefulness in staging.

CT

At many institutions, contrast-enhanced MDCT is the preferred imaging technique for the staging of pancreatic cancer. It is quick, robust, and especially has superb spatial resolution. It is particularly useful for the assessment of tumor involvement of vascular structures. Imaging should be obtained as a multiphasic acquisition, with a late arterial phase timed to optimize peak enhancement of the pancreas (typically at 45-50 seconds after the start of contrast injection, depending on injection rate) to maximize visualization of the primary tumor, and a portal venous phase for optimum enhancement of venous structures and to maximize detectability of typically hypodense liver metastases (typically 70 seconds after the start of contrast injection). Many practices employ use of bolus tracking to optimize timing of the arterial and portal venous phase of enhancement. A recent study comparing 64-detector row MDCT and 3T MRI showed overall comparable sensitivities and specificities between the two modalities regarding resectability (CT sensitivity 87%, specificity 63% to 75%; MRI sensitivity 93%, specificity 50% to 75%). A recent critical review of CT and MRI that was based on reports published between 1997 and 2009 also showed that CT and MRI performed comparably with both modalities showing improvement on more recent studies. Notably, unenhanced CT has poor soft tissue contrast in comparison to MRI and therefore has marginal usefulness during staging. It should also be noted anecdotally, for the reasons given above, that in those institutions with MRI and CT capabilities, CT is typically the more used modality in the setting of staging pancreatic cancer.

MRI

Many MRI advances have been made in the past several years with regard to robustness of image quality, speed of image acquisition, and resolution in imaging. As noted above, MRI has been reported in a recent study to have a sensitivity of 93% and specificity of 50% to 75% for determination of resectability, and studies comparing state-of-the-art CT with state-of-the-art MRI report a similar overall performance. MRI has inherently better soft tissue contrast than unenhanced CT enabling superior visualization of tumor without intravenous (IV) contrast administration. Although the authors could not identify studies specifically addressing noncontrast MRI staging sensitivity and specificity, MRI is preferable because techniques such as flow sensitive sequences and diffusion-weighted imaging provide valuable information when IV contrast is contraindicated.

EUS

EUS is a relatively invasive modality whose primary role in the evaluation of pancreatic cancer has been in the detection and guidance of biopsy for confirmation of tumor as discussed in the ACR Appropriateness Criteria® jaundice . It has evolved into a useful modality to complement CT and MRI for the workup of questionable lesions given a sensitivity of near 100% and specificity of reportedly ≥95% for tumors <2 cm in the absence of administration of IV contrast. The ability to perform fine-needle aspiration (FNA) also proves useful in the assessment of questionable metastatic lymph nodes, but EUS is unable to assess for potential liver metastases or peritoneal disease. Furthermore, the results have been mixed regarding its sensitivity and specificity for vascular involvement when compared to CT or

MRI. In this regard, EUS may be helpful as a problem solver when there are contraindications to both MRI and contrast-enhanced CT. However, as will be discussed subsequently in variant 1 in greater detail, criteria for describing vascular invasion on EUS have not been standardized rendering comparative assessments limited.

FDG-PET/CT

There is considerable variation in how FDG-PET/CT is performed between institutions, with regard to the presence or absence of IV contrast, the presence or absence of oral contrast, as well as other parameters including slice thickness, and field-of-view. When performed without IV contrast, FDG-PET/CT has the same limitations as unenhanced CT with regard to local staging of the tumor. When performed with IV contrast, images are typically obtained at a single phase of contrast enhancement. Studies that have recently examined the role of FDG-PET/CT in the staging of pancreatic cancer have focused on its supplementary ability to detect additional distant metastases beyond those detected by conventional cross-sectional imaging of the abdomen and pelvis or chest, abdomen, and pelvis given the advantage that FDG-PET/CT is a whole-body examination.

Discussion of Procedures by Variant

Variant 1: Pancreatic Ductal Adenocarcinoma. Initial Staging Pretreatment

CT

With regard to assessing vascular involvement, one of the limitations of the literature are varying definitions for what constitutes vascular invasion or "vascular involvement," and even more, the criteria for resectability as a definition of "resectable" disease varies between institutions. As an example, a recent study of 111 patients defined its criterion for arterial invasion as any contiguity between tumor and vessel, whereas venous invasion was described as only being present if there was a 50% or greater contiguity of tumor with a given vein. A meta-analysis of examinations performed between 1999 and 2010 that compared CT and MRI showed that CT had a sensitivity of approximately 71% and specificity of approximately 92% for identification of vascular invasion across arteries and veins, which is comparable to MRI.

Nodal staging is a limitation for any of the imaging modalities because of its relative insensitivity to micrometastases detection. Another challenge is the varying imaging criteria for identifying potential nodal involvement between studies. A recent study that used, as criterion for nodal involvement, a nodal short axis diameter of >5 mm or morphologic features of necrosis showed an accuracy of 55% to 60% for the detection of nodal metastatic disease, which is similar to findings seen on older studies regardless of criteria (44%-68%).

Little information is available regarding sensitivity for detecting liver metastases originating from pancreatic cancer for the current generation of MDCT scanners (64-detector row or better). Two studies that have compared 64-detector row MDCT with 3T MRI showed for CT a sensitivity of 70% to 76% in the detection of liver metastases compared to 90% to 100% for MRI with either gadobenate dimeglumine or gadoxetic acid. One group studied 192 patients to compare 4-detector row multiphasic MDCT with CT arterial portography (CTAP) and computed tomography-assisted hepatic arteriography (CTHA) with intraoperative US as the gold standard in the assessment of those patients identified as not having metastatic disease. Of note, CTAP with CTHA is an invasive technique requiring a separate interventional procedure for placement of an arterial catheter to optimize contrast evaluation by CT, and as such is not practiced routinely. Furthermore, MDCT was performed with only four detectors, which is far less than many contemporary scanners. In that study, MDCT had a sensitivity of 48.4% and specificity of 98% for liver metastases compared to CTAP + CTHA, which had a sensitivity of 94.2% and specificity of 82.7%. Although the results of CTAP + CTHA were impressive, the data regarding current state-of-the-art MDCT are not representative of modern practice.

Peritoneal metastases from pancreatic cancer are typically difficult to identify by any of the modalities because of their typically small size or miliary appearance. In the literature search, no studies that tried to assess overall sensitivity for peritoneal metastases by CT were available, likely because patients were

already found to have unresectable disease secondary to other causes such as liver metastases or extensive vascular involvement. Studies that were retrieved in the examination focused on the question of the additional usefulness of preoperative laparoscopic assessment following CT. Results have been controversial, but indirectly these provide information regarding whether CT is sufficient for detection of peritoneal disease for disease management. A meta-analysis of 1,015 patients across 15 studies concluded that, on average, out of 100 patients identified as having resectable disease based on CT, use of follow-up laparoscopy would have avoided 23 unnecessary laparotomies. Another recent meta-analysis that analyzed 12 studies between 1999 and 2010 showed a pooled sensitivity of laparoscopic assessment of 75% for peritoneal implants. In the authors' anecdotal experience, institutions will variably use laparoscopy, sometimes in the setting of suspicion for peritoneal disease, but for some others more globally, with or without laparoscopic peritoneal washing, with the plan to proceed directly to laparotomy at the same setting for planned pancreatic resection in the absence of detection of peritoneal disease.

MRI

The limitations noted above for studies regarding CT and the accuracy of assessing vascular involvement by tumor apply to MRI as well (with differences in criteria for defining a vessel as involved by tumor, differences in definitions of resectability, and varying generations of equipment, etc.). Fewer studies are available on the topic of MRI and staging of pancreatic cancer than there are for CT. A study comparing 64-detector row MDCT versus 3T MRI showed for MRI a sensitivity for vascular infiltration of 50% to 80% and a specificity of 96% to 98%. These findings are similar to those found on a meta-analysis of eight studies published between 1997 and 2004 that showed a pooled sensitivity of 67% and pooled specificity of 94% that was not significantly different from CT. Therefore, MRI and CT can be considered likely comparable with regard to assessment of vascular involvement by tumor.

As noted above, assessment for nodal staging on cross-sectional imaging is limited because of its current inability to identify micrometastases. A critical review article on staging reportedly noted an accuracy ranging from 61% to 77% in radiology studies from 2004 to 2009 for the detection of nodal involvement by tumor.

In contrast, MRI has been shown to be likely superior for the detection of liver metastases. Two studies that compared 64-detector row MDCT with 3T MRI showed that CT had a sensitivity of 70% to 76% for the detection of liver metastases compared to 90% to 100% for MRI with either gadobenate dimeglumine or gadoxetic acid.

The literature search identified only very limited information with regard to MRI and pancreatic cancer peritoneal metastases. A study evaluating the usefulness of staging laparoscopy following staging MRI noted that the yield of staging laparoscopy was marginal and cost effectiveness was reportedly poor for use of this approach.

EUS

A recent meta-analysis of 29 studies that incorporated EUS showed EUS to have a pooled sensitivity of 85% and specificity of 91% for vascular invasion. Notably, the same study noted that the criteria for identifying arterial invasion have not been standardized, which is a constraining factor when attempting to compare between modalities and likely accounts for the wide range of sensitivity for vascular invasion of EUS in this meta-analysis (62% to 100%). The authors noted in their review that there are little comparative data between arterial and venous assessments, and that overall it appeared that CT and EUS performed comparably for assessing venous involvement and that CT may be superior for the assessment of invasion of arterial structures.

With regard to nodal disease, EUS has the advantage in that it can be combined with FNA to greatly improve its specificity. A recent meta-analysis of 8 studies showed a pooled sensitivity of 58% and specificity of 85% for detecting nodal metastases with EUS alone. Although the meta-analysis did not include an assessment of multiple studies with EUS that included FNA, the authors did note that EUS would likely improve nodal staging, and cited a study that reported a sensitivity of 82% and specificity of 100% to confirm malignant adenopathy.

Because of its narrow field-of-view, and the limited region of anatomic coverage, EUS does not have a role for assessment of peritoneal disease. EUS allows for a limited examination of the left liver lobe and possible FNA of these lesions. No studies have directly compared the accuracy of EUS and cross-sectional imaging for left-sided liver metastasis. Imaging of the right liver is difficult and unreliable by EUS.

US

Difficulties in visualizing the pancreas in detail because of either body habitus or commonly interposed bowel gas limit the usefulness of transabdominal US for staging.

FDG-PET/CT

As noted earlier, there is considerable variability in how the CT portion of the examination is obtained for FDG-PET/CT with regard to whether IV or oral contrast is administered. When performed without IV contrast, it does not have a role in the assessment for potential vascular involvement. When performed with IV contrast enhancement, it is typically acquired as a single phase of contrast enhancement at variable slice thickness and variable reconstructed display field-of-view between institutions. These parameters would affect the usefulness and effectiveness of local staging. FDG-PET/CT, when used in the setting of preoperative staging, is therefore typically used as a whole-body examination for follow-up to contrast-enhanced CT or MRI, which themselves would already provide information regarding liver metastases, potential peritoneal implants, and possible adenopathy. This is likely why most of the studies retrieved in our literature search evaluated the usefulness of FDG-PET/CT as a follow-up study whole body examination to conventional cross-sectional imaging for the detection of unexpected distant metastases. One of the challenges encountered in evaluating the studies is that often distant metastases (liver, peritoneal, lung, bone, nodes) were put together into a single group rather than subgroups by the type of distant metastasis. The results are variable across studies with the detection rate of unexpected distant metastases generally identified in patients as probably resectable based on contrast-enhanced CT or MRI, ranging from 2.5% to 41%. A recent meta-analysis of FDG-PET/CT imaging (4 studies, 101 patients) showed a pooled sensitivity of 64% and specificity of 81% for metastatic nodal disease, and a sensitivity of 67% and specificity of 96% for liver metastases.

Variant 2: Pancreatic Ductal Adenocarcinoma. Follow-up Post-neoadjuvant Therapy. Evaluate Resectability for Borderline Resectable Tumor

Only five articles that addressed the topic of preoperative therapy in the context of staging a tumor were identified in the literature search.

CT

Only very limited information is available regarding staging in the setting of preoperative chemotherapy and/or radiation therapy. Challenges include differences in treatment regimens. A small study comparing 31 patients who had undergone neoadjuvant therapy (between 2005 and 2010) for locally advanced disease that went on to attempted curative resection with a control group of 41 patients who went directly to surgery showed that the accuracy of MDCT (in this study, 16- and 64-detector row) for determining resectability was significantly less in the neoadjuvant group (58% versus 83%), primarily secondary to an overestimation of vascular invasion. This study was limited by a mix of treatment regimens including chemotherapy alone, radiation therapy alone, and combination chemoradiation. Other studies have also shown that imaging signs of vascular involvement by tumor persist even after successful therapy because of the inability of imaging to distinguish viable from nonviable tumor. No information was available from the search in regard to the accuracy of identifying nodal metastases, liver metastases, or peritoneal disease in the setting of neoadjuvant therapy.

MRI

The literature search did not identify any studies that examined the accuracy of MRI in the assessment of staging following preoperative therapy.

EUS

The literature search did not identify any studies that examined the accuracy of EUS in the assessment of vascular involvement by tumor following neoadjuvant therapy.

US

The literature search did not identify any studies that examined the accuracy of transabdominal US in the assessment of vascular involvement by tumor following neoadjuvant therapy.

FDG-PET/CT

The literature search did not identify any studies that examined the accuracy of FDG-PET/CT in the assessment of staging following neoadjuvant therapy.

Reporting of Imaging Findings for Staging Pancreatic Cancer

An emerging issue has been the reporting of findings for staging for pancreatic cancer by radiologists, namely, the usefulness of structured reporting or template reporting versus free-form (nonstructured) dictation. A single institution study had surgeons evaluate 48 structured and 72 nonstructured reports and found that information for surgical planning was readily accessible in 60% to 98% of structured reports, but only 32% to 54% in nonstructured reports. In a retrospective study of 200 reports reviewed by radiologists, it was noted that in 20.3% of reports, resectability status could not be determined based on the report alone.

Societies such as the American Pancreatic Association, the Society of Abdominal Radiology, and the Radiological Society of North America have made resources available with regard to guidelines and templates for reporting. In brief, these guidelines incorporate descriptions of the morphology and size of the primary tumor, its effect on ducts, descriptions of extension beyond the pancreas, descriptions of involvement of vascular structures using standardized terminology (degrees of circumferential involvement, or the words "abutment" for up to 180° of vessel involvement or "encasement" for greater than 180° of involvement), descriptions of sites of suspicious nodes based on size criteria or morphology, and findings on the inspection of typical sites of metastatic spread (liver, peritoneum, lung, and bone).

Summary of Recommendations

> Pancreatic adenocarcinoma is often diagnosed at advanced disease stage with poor prognosis. Surgical advances in conjunction with combination systemic therapies and radiation therapy have been suggested to improve outcomes. Shifts in treatment approach, particularly attempts to increase surgical candidacy, have been driven by complete surgical resection being the only possible option for cure. Sophisticated vascular surgery is performed to remove sites of potential perineural tumor spread. Such changes have resulted in not only considering patients with resectable tumor but also borderline resectable tumor as surgical candidates. From a radiology perspective, this has translated into an expectation of greater report detail and specifics. Beyond identification of metastatic disease, appropriate description of extent of involvement of key vascular structures (especially SMA), tumor size (whether 2 cm or smaller), and location is required.
> MDCT with arterial and portal venous phase imaging and dynamic contrast-enhanced MRI are recommended for primary staging. Although preference tends to reflect institutional experience and practice, MDCT is preferred by many. EUS and FDG-PET/CT can be useful problem-solving techniques for biopsy guidance and confirmation of distant metastases, respectively.
> Limited data are available regarding accuracy of imaging for preoperative staging following chemotherapy and/or radiation therapy. Varied treatment regimens present a particular challenge in assessing vascular involvement, and performance of state-of-the-art MDCT or MRI for determining resectability is compared to patients going straight to surgery.

Abbreviations

> CT, computed tomography
> FDG-PET, fluorine-18-2-fluoro-2-deoxy-D-glucose positron emission tomography
> IV, intravenous

MRI, magnetic resonance imaging
US, ultrasound

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."		

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Scope

Disease/Condition(s)

Pancreatic ductal adenocarcinoma

Guideline Category

Evaluation

Management

Clinical Specialty

Endocrinology

Family Practice

Gastroenterology

Internal Medicine

Oncology

Radiology

Intended Users

Advanced Practice Nurses

Health Care Providers

Hospitals

Managed Care Organizations

Physicians

Students

Utilization Management

Guideline Objective(s)

To evaluate the appropriateness of imaging procedures for staging of pancreatic ductal adenocarcinoma

Target Population

Patients with pancreatic ductal adenocarcinoma

Interventions and Practices Considered

1. Computed tomography (CT), abdomen and pelvis
    - With intravenous (IV) contrast
    - Without and with IV contrast
    - Without IV contrast
2. Magnetic resonance imaging (MRI), abdomen
    - Without and with IV contrast
    - Without IV contrast
3. Ultrasound (US), abdomen
    - Transabdominal
    - Endoscopic
4. Fluorine-18-2-fluoro-2-deoxy-D-glucose positron emission tomography (FDG-PET)/CT, skull base to mid-thigh

Major Outcomes Considered

- Utility of imaging procedures in the staging of pancreatic ductal adenocarcinoma
- Sensitivity, specificity, and accuracy of imaging procedures in staging of pancreatic ductal adenocarcinoma imaging of deep inferior epigastric arteries for surgical planning

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Literature Search Summary

A literature search was conducted in May 2015 and updated in May 2017 to identify evidence for the *ACR Appropriateness Criteria® Staging of Pancreatic Ductal Adenocarcinoma* topic. Using the search strategy described in the literature search companion (see the "Availability of Companion Documents" field), 355 articles were found. Twenty-two articles were used in the topic. The remaining articles were not used due to either poor study design, the articles were not relevant or generalizable to the topic, or the results were unclear, misinterpreted, or biased.

The author added 33 citations from bibliographies, Web sites, or books that were not found in the literature search, including 21 articles outside of the search date ranges.

Two citations are supporting documents that were added by staff.

See also the American College of Radiology (ACR) Appropriateness Criteria® literature search process document (see the "Availability of Companion Documents" field) for further information.

Number of Source Documents

The literature search conducted in May 2015 and updated in May 2017 found 22 articles that were used in the topic. The author added 33 citations from bibliographies, Web sites, or books that were not found in the literature search, including 21 articles outside of the search date ranges. Two citations are supporting documents that were added by staff.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Definitions of Study Quality Categories

Category 1 - The study is well-designed and accounts for common biases.

Category 2 - The study is moderately well-designed and accounts for most common biases.

Category 3 - The study has important study design limitations.

Category 4 - The study or source is not useful as primary evidence. The article may not be a clinical study, the study design is invalid, or conclusions are based on expert consensus.

> The study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
>
> *Or*
>
> The study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
>
> *Or*
>
> The study is an expert opinion or consensus document.

Category M - Meta-analysis studies are not rated for study quality using the study element method because the method is designed to evaluate individual studies only. An "M" for the study quality will indicate that the study quality has not been evaluated for the meta-analysis study.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The topic author assesses the literature then drafts or revises the narrative summarizing the evidence found in the literature. American College of Radiology (ACR) staff drafts an evidence table based on the analysis of the selected literature. These tables rate the study quality for each article included in the narrative.

The expert panel reviews the narrative, evidence table and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the variant table(s). Each individual panel member assigns a rating based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Overview

The purpose of the rating rounds is to systematically and transparently determine the panels' recommendations while mitigating any undue influence of one or more panel members on another individual panel members' interpretation of the evidence. The panel member's rating is determined by reviewing the evidence presented in the Summary of Literature Review and assessing the risks or harms of performing the procedure or treatment balanced with the benefits of performing the procedure or treatment. The individual panel member ratings are used to calculate the median rating, which determines the panel's rating. The assessment of the amount of deviation of individual ratings from the panel rating determines whether there is disagreement among the panel about the rating.

The process used in the rating rounds is a modified Delphi method based on the methodology described in the RAND/UCLA Appropriateness Method User Manual.

The appropriateness is rated on an ordinal scale that uses integers from 1 to 9 grouped into three categories (see the "Rating Scheme for the Strength of the Recommendations" field).

Determining the Panel's Recommendation

> Ratings represent an individual's assessment of the risks and benefits of performing a specific procedure for a specific clinical scenario on an ordinal scale. The recommendation is the appropriateness category (i.e., "Usually appropriate", "May be appropriate", or "Usually not appropriate").
> The appropriateness category for a procedure and clinical scenario is determined by the panel's median rating without disagreement (see below for definition of disagreement). The panel's median rating is calculated after each rating round. If there is disagreement after the second rating round, the rating category is "May be appropriate (Disagreement)" with a rating of "5" so users understand the group disagreed on the final recommendation. The actual panel median rating is documented to provide additional context.

Disagreement is defined as excessive dispersion of the individual ratings from the group (in this case, an Appropriateness Criteria [AC] panel) median as determined by comparison of the interpercentile range (IPR) and the interpercentile range adjusted for symmetry (IPRAS). In those instances when the IPR is greater than the IPRAS, there is disagreement. For a complete discussion, please refer to chapter 8 of the RAND/UCLA Appropriateness Method User Manual.
Once the final recommendations have been determined, the panel reviews the document. If two thirds of the panel feel a final recommendation is wrong (e.g., does not accurately reflect the evidence, may negatively impact patient health, has unintended consequences that may harm health care, etc.) and the process must be started again from the beginning.

For additional information on the ratings process see the Rating Round Information document (see the "Availability of Companion Documents" field).

Additional methodology documents, including a more detailed explanation of the complete topic development process and all ACR AC topics can be found on the ACR Web site (see also the "Availability of Companion Documents" field).

Rating Scheme for the Strength of the Recommendations

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Cost Analysis

A study evaluating the usefulness of staging laparoscopy following staging magnetic resonance imaging (MRI) noted that the yield of staging laparoscopy was marginal and cost-effectiveness was reportedly poor for use of this approach.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current medical evidence literature and the application of the RAND/UCLA appropriateness method and expert panel consensus.

Summary of Evidence

Of the 57 references cited in the *ACR Appropriateness Criteria® Staging of Pancreatic Ductal Carcinoma* document, 14 are categorized as therapeutic references including 5 well-designed studies, 5 good-quality studies, and 1 quality study that may have design limitations. Additionally, 37 references are categorized as diagnostic references including 6 good-quality studies, and 14 quality studies that may have design limitations. There are 20 references that may not be useful as primary evidence. There are 6 references that are meta-analysis studies.

Although there are references that report on studies with design limitations, 16 well-designed or good-quality studies provide good evidence.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Distant stage disease at diagnosis is associated with only a 15% 1-year and 2% 5-year survival. Given the poor prognosis, accurate staging is essential and pivotal to patient management decisions that are decided through a multidisciplinary approach. Imaging plays a critical role in pancreatic cancer staging and therapeutic decision process.

Potential Harms

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the American College of Radiology (ACR) Appropriateness Criteria® Radiation Dose Assessment Introduction document (see the "Availability of Companion Documents" field).

Qualifying Statements

Qualifying Statements

- The American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert

panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

- ACR seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply society endorsement of the final document.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

Living with Illness

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Qayyum A, Tamm EP, Kamel IR, Allen PJ, Arif-Tiwari H, Chernyak V, Gonda TA, Grajo JR, Hindman NM, Horowitz JM, Kaur H, McNamara MM, Noto RB, Srivastava PK, Lalani T, Expert Panel on Gastrointestinal Imaging. ACR Appropriateness CriteriaÂ® staging of pancreatic ductal adenocarcinoma. Reston (VA): American College of Radiology (ACR); 2017. 12 p. [57 references]

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2017

Guideline Developer(s)

American College of Radiology - Medical Specialty Society

Source(s) of Funding

The funding for the process is assumed entirely by the American College of Radiology (ACR). ACR staff support the expert panels through the conduct of literature searches, acquisition of scientific articles, drafting of evidence tables, dissemination of materials for the Delphi process, collation of results, conference calls, document processing, and general assistance to the panelists.

Guideline Committee

Committee on Appropriateness Criteria, Expert Panel on Gastrointestinal Imaging

Composition of Group That Authored the Guideline

Panel Members: Aliya Qayyum, MD (*Principal Author*); Eric P. Tamm, MD (*Research Author*); Ihab R. Kamel, MD, PhD (*Panel Chair*); Peter J. Allen, MD; Hina Arif-Tiwari, MD; Victoria Chernyak, MD, MS; Tamas A. Gonda, MD; Joseph R. Grajo, MD; Nicole M. Hindman, MD; Jeanne M. Horowitz, MD; Harmeet Kaur, MD; Michelle M. McNamara, MD; Richard B. Noto, MD; Pavan K. Srivastava, MD; Tasneem Lalani, MD (*Specialty Chair*)

Financial Disclosures/Conflicts of Interest

Disclosing Potential Conflicts of Interest and Management of Conflicts of Interest

An important aspect of committee operations is the disclosure and management of potential conflicts of interest. In 2016, the American College of Radiology (ACR) began an organization-wide review of its conflict of interest (COI) policies. The current ACR COI policy is available on its Web site. The Appropriateness Criteria (AC) program's COI process varies from the organization's current policy to accommodate the requirements for qualified provider-led entities as designated by the Centers for Medicare and Medicaid Services' Appropriate Use Criteria (AUC) program.

When physicians become participants in the AC program, welcome letters are sent to inform them of their panel roles and responsibilities, including a link to complete the COI form. The COI form requires disclosure of all potential conflicts of interest. ACR staff oversees the COI evaluation process, coordinating with review panels consisting of ACR staff and members, who determine when there is a conflict of interest and what action, if any, is appropriate. In addition to making the information publicly available, management may include exclusion from some topic processes, exclusion from a topic, or exclusion from the panel.

Besides potential COI disclosure, AC staff begins every committee call with the conflict of interest disclosure statement listed below reminding members to update their COI forms. If any updates to their COI information have not been submitted, they are instructed not to participate in discussion where an undisclosed conflict may exist.

Finally, all ACR AC are published as part of the Journal of the American College of Radiology (JACR) electronic supplement. Those who participated on the document and are listed as authors must complete the JACR process that includes completing the International Committee of Medical Journal Editors (ICMJE) COI form which is reviewed by the journal's staff/publisher.

Dr. Tamm reports grants from General Electric, outside the submitted work. The other authors have no conflicts of interest related to the material discussed in this article.

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the American College of Radiology (ACR) Web site .

Availability of Companion Documents

The following are available:

ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2017. Available from the American College of Radiology (ACR) Web site .

ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 2015 Feb. 1 p. Available from the ACR Web site .

ACR Appropriateness Criteria®. Evidence table development. Reston (VA): American College of Radiology; 2015 Nov. 5 p. Available from the ACR Web site .

ACR Appropriateness Criteria®. Topic development process. Reston (VA): American College of Radiology; 2015 Nov. 2 p. Available from the ACR Web site .

ACR Appropriateness Criteria®. Rating round information. Reston (VA): American College of Radiology; 2017 Sep. 5 p. Available from the ACR Web site .

ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2017. 4 p. Available from the ACR Web site .

ACR Appropriateness Criteria®. Manual on contrast media. Reston (VA): American College of Radiology; 2017. 125 p. Available from the ACR Web site .

ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 2017 Mar. 4 p. Available from the ACR Web site .

ACR Appropriateness Criteria® staging of pancreatic ductal adenocarcinoma. Evidence table. Reston (VA): American College of Radiology; 2017. 33 p. Available from the ACR Web site .

ACR Appropriateness Criteria® staging of pancreatic ductal adenocarcinoma. Literature search. Reston (VA): American College of Radiology; 2017. 2 p. Available from the ACR Web site .

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on March 15, 2018. The guideline developer agreed

to not review the content.

This NEATS assessment was completed by ECRI Institute on February 14, 2018. The information was verified by the guideline developer on March 15, 2018.

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